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Computational Project 2

Problem 1.

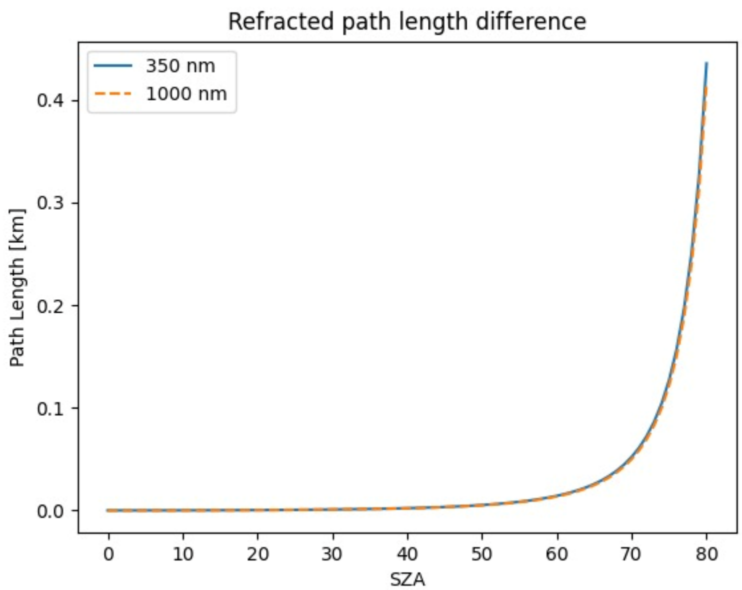

Figure 1. Refracted path length difference

Figure (1) shows a difference path length between a refracting and non-refracting atmosphere as a function of SZA for each wavelength. As can be seen from the figure, the characteristic of the curve is showing a change in path length that is very small but then it starts to look exponentially increasing. A noticeable increase is seen around the SZA > 60. The difference in wavelength does not really affect the change in path length due to the refraction. The difference in path length for 350 nm and 1000 nm is higher when the SZA is increased. Prior to SZA 60, the difference in path length between 350 nm and 1000 nm was below the value of 0.015 km. The maximum difference between the two wavelengths is at SZA 80 in the range of 0.018 km.

Problem 2.

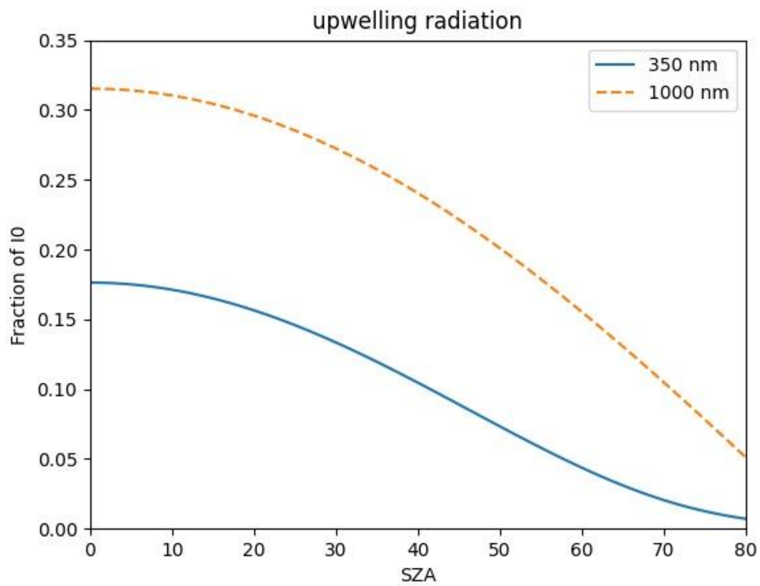

Figure 2. The upwelling radiation at the satellite as a fraction of

I0

The Figure (2) shows that at a higher SZA, the light captured by the satellite is smaller because if we look the Rayleigh scattering cross section formula given by $\sigma_s = \frac{8\pi^3(m_r-1)^2}{3\lambda^4 N_s^2} f(\delta)$, when the incoming angle on each layer is higher, the radiation that us being scattered up is lower and this is also supported with the effect of reduced radiation intensity due to the increase in SZA value. In this figure can be seen that the total radiation intensity returning to the satellite is higher at wavelength of 1000 nm though if we look at our formula, the condition should be that if wavelength is high, the scattering value will be lower. However, the upwelling radiation at 1000 nm looks higher because the radiation captured by the satellite also contains radiation that is reflected from the ground surface, which is the total downwelling radiation, and the total downwelling radiation at wavelength of 1000 nm is significantly higher compared to 500 nm.

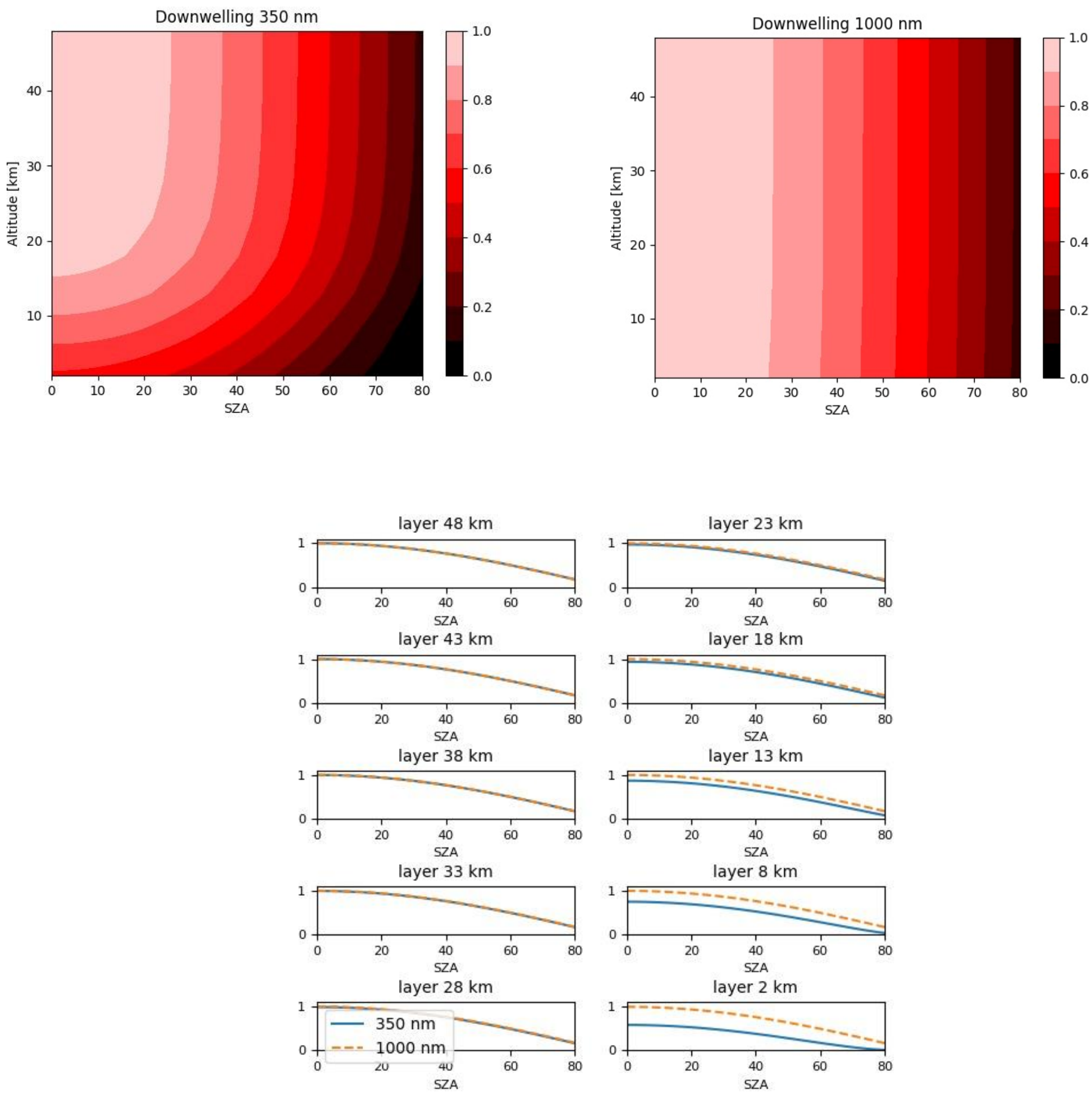

Figure 3. The fraction of downwelling radiation seen by each layer for each wavelength

The reduction in the downwelling radiation value in each layer due to scattering is seen more significantly at wavelength of 350 nm and the reduction was further supported by SZA. At a longer wavelength, the fraction of Io is higher. This effect is represented in the Rayleigh scattering cross section formula given by $\sigma_s = \frac{8\pi^3(m_r-1)^2}{3\lambda^4 N_s^2} f(\delta)$, the higher the wavelength will reduce the σ_s , the reduce in σ_s will reduce our scattering value. The downwelling radiation begins to decrease rapidly at an altitude of +- 20km.